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Beans and pease from England, planted in America, soon dwindle much from the originals ; and the alteration that soils and climates produce on wheat is so well known, that all careful farmers in Europe change their seed-grain often ; this is so remarkable in America, it is observed, that the red flinty wheat which grows in the strong mountainous lands, when sowed in low moist places, undergoes a gradual change for four years, and then becomes light coloured, thin skinned, and of a soft texture ; and that this wheat sowed in the high lands, takes the same time to recover its natural colour and quality. Therefore if the injury of wheat from flies depends on the soft quality it contracts by its growth in moist low lands, a proper annual change of seed-grain, will alone prove an easy and certain remedy against the present destructive and alarming evil amongst us.

*Observations on the native SILK WORMS of North-America,
by Mr. MOSES BARTRAM.*

Read before the Society, March 11, 1768.

I H A D, for a long time, a desire to know, if some of the wild silk worms of North-America could, with proper care, be propagated to advantage ; accordingly, in March, 1766, I made an excursion along the banks of Schuylkill, in search of some pods or cocoons, in which the worms spin themselves up and lie concealed all the winter, in the nymph state, preparing for a change in the spring, namely, from an aurelia to a fly.

I WAS so lucky as to find five cocoons that had live found hymphæ in them. These five I placed in my garret opposite to a window, that fronted the sun rising. I did this, that the warmth of the sun might forward their coming out.

May 10. ONE of the flies came out ; but the window happening to be left open it made its escape.

May

May 13. ONE of my pods produced a large brown fly, beautifully spotted, next day two more of them produced each a fly.

May 17. ONE of the flies, which came out of a large loose pod, began to lay eggs. On the 22d, the other two, which were males, grew very weak and feeble and unable to fly. Next day one of them died, and the day following the other died; the female fly all this time continuing to lay eggs; on the 24th at night she also died, having laid near three hundred eggs. *May 31,* my last pod produced a large female fly, of the brown kind like the rest. But there being no male I could expect no increase from it. *June 3d,* she began to lay eggs and continued some days: On the 8th she died, having laid upwards of two hundred eggs. These which my last fly laid looked at first large and full, but in a few days they began to shrivel and be indented in the middle, as did all the rest. However, I folded them all up in separate papers and laid them by, to see if any would hatch the spring following.

THE male fly is less than the female, but his colours are brighter and more beautiful.

IN the spring of the year 1767, I examined the eggs, and found them all dry, and not likely to produce worms; from whence I concluded they had not been impregnated by the males. This was a disappointment to me. But being still of opinion, that they might be propagated, I determined to make another trial with more caution and circumspection. Accordingly, I set out in search of cocoons, and gathered several of them both from the swamps and upland. Those from the swamps I got chiefly off the alder; those from the upland, off the wild crab-tree, and the viburnum or black haw bushes.

THESE pods I placed as I had the others, before my garret window, where the sun might shine on them, as soon as it arose, and a great part of the forenoon. When I expected the flies were near coming out, I tacked coarse cloths up against the windows on the inside, not only to darken the room, but
also

also for the flies to settle on, and to prevent them, in attempting to make their escape, from beating their legs and wings to pieces against the glass, which I found to be the case last year, and which it is probable, prevented their copulating.

May 16. THREE of my cocoons produced each a fine large fly of the brown kind, the same as those of last year. The two following days two more flies made their appearance, and one of the eldest began to lay eggs, which not being impregnated, dried up and yielded no increase.

May 19. ONE of the males that came out on the 16th, copulated with the female that was produced on the 18th. They continued together about twenty-four hours; a common case with most of the insect tribe, which lay a great number of eggs at once. And something similar may be observed in some other animals.

May 22. THIS female fly began to lay eggs which looked plump and fine. Though I had now several flies, yet this was the only one from which I had any increase.

June 2. THE last of my flies died, all expiring regularly as they came out. The period of their existence is short, seldom exceeding nine or ten days, though some of the females lived to the age of fourteen or fifteen, as I found by one I had last year.

June 3. THE eggs that were impregnated began to hatch and produce worms, to which I presented for food the leaves of our common mulberry; but they did not seem fond of them. I laid before them several other kinds of vegetables, and observed that they seemed best pleased with the alder.

June 4th, 5th, and 6th. THE eggs continued hatching and producing young worms.

June 8. THOSE first hatched left off feeding, shrunk up short, and seemed motionless. I imagined they were sick and changed their food, trying almost every kind of vegetable,
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in hopes of finding something that would agree with them better; but all to no purpose. Having killed several in shifting them from one kind of food to another, while the rest still continued in the same torpid state, notwithstanding all I could do, I thought all my hopes of raising them were frustrated and concluded they would perish.

June 9. I WAS agreeably surprized to see the little animals, that I had given over as dead, creeping out of their old skins, and appearing much larger and more beautiful than before. Finding themselves disengaged, in a little time, they turned about and fell to devouring their old coat, which seemed a delicious repast to them; after which they rested about twelve hours, and then began to feed on leaves as formerly with great eagerness.

June 15. THE eldest worms again left off feeding, shrunk up very short, and appeared fixed on the leaves almost motionless. In this situation they continued until the 17th, on which day, after appearing to be very violently convulsed for near half an hour, they threw off another skin, which they eat as before, and then resting about twelve hours, fell to their usual food.

June 20. ONE of my worms, that had just disengaged itself from its old covering, whilst it yet remained weak, was destroyed by a kind of bug armed with a long bill, with which it pierced the side of the worm, and sucked out its vitals. This bug, which I fancy, I must have brought in with the leaves, I take to be a common enemy to the silk worm in its tender state. Its bill is so long, that it can stand at some distance from the worm, and with its weapon wound it, notwithstanding the bunches of hair or bristles, in form of a pencil, with which the worm is covered, and which are its principal defence.

June 23. MY oldest worms left off feeding, shrunk up, and on the 25th, threw off their third covering, which they devoured, and, after resting the usual time, returned to feed as before.

July

July 2. THEY left off feeding the fourth time, and on the 5th parted with their fourth covering, after eating which, and resting as usual, they continued to feed on the leaves.

It is remarkable every change they undergo adds fresh beauty to the worms, and in every new dress, they appear with more gaudy colours and lively streaks.

July 22 Two of my oldest worms left off feeding and began to wander about in search of a proper place to spin. Thereupon I got sticks, in which I fixed a number of pegs for the greater conveniency of the worms ; though they can spin in any place, where they have or can form an angle for their webs. After wandering about some time, they fixed at last and began to spin in a curious manner.

July 23. Two left off feeding ; these I placed on the racks I had made, which I fixed in glass bottles to prevent the worms from getting off : For I found they were apt to ramble greatly before they could fix on a place to their liking, if they were not suffered to spin among the leaves they feed on ; in which case they begin to spin soon after they leave of feeding. But I did not like to suffer this, as they seemed fond of drawing bits of twigs and leaves into their nests, which must obstruct the unwinding the silk. One of them spun on the rack, the other got to the window and spun in the angle of that.

July 24. Five left off feeding ; and having wandered about all night began, early next morning, to spin. In like manner the rest of my worms, as fast as they arrived at a state of maturity, daily applied themselves to spinning or wrapping themselves up in cocoons. *August 10.* The last worm left off feeding, and like the rest wrapped itself up, in which state I expect they will all remain, until *May* next, when each of them, I hope, will produce a beautiful fly.

It seems strange there should be an interval of no less than nineteen days between the time the first and last worm began to spin, though they were all hatched within three or four days
of

of one another, which was nearly the space of time the parent fly was laying the egg. Whether this was owing to the weakness or strength of the vital principle in some more than in others, or whether to the shifting their food, or to their being frightened, and thereby prevented from feeding, I cannot tell. Farther experiments may possibly explain the matter.

THE method I took to raise these worms, with the least trouble to myself, as I live in town, and consequently had to bring food for them out of the country, was as follows: I filled several bottles with water; in these bottles I placed branches of such vegetables as the worms feed on. I placed the bottles so near each other, that when any of their food withered, the worms might crawl to what was fresh. By this means I kept their food fresh for near a week. I always kept the bottles full of water, whereby the worms were supplied with drink, which seems necessary for them. Without it they will not feed kindly. They commonly crawled down two or three times a day, drank heartily, and then returned to feeding. The leaves of the apple tree seemed as agreeable to the worms as any I tried; and they answered best, as they kept fresh in the water longer than any other.

FROM sundry experiments, I found the worms averse to changing their food. On whatever they first begin to feed, they keep to it.

If any should incline to propagate these worms, I would propose the following method. Let long narrow troughs be made, with a number of notches along the edges. In the bottom of the troughs, on the outside, let pieces of straight wood be fixed, so that the branches, on which the worms are to feed, may lie in the notches, and their ends be fixed under the piece of wood at the bottom. This would keep them steady, and lying thus inclined, they would more freely imbibe the water for the refreshment of the leaves. The dung of the worms would fall clear of the troughs, and the water thereby be clean for their drink. The troughs should be always kept full of water, and placed in a shade, secure from the violence of wind, which might shake down the worms;

but not too much confined, because a little air is agreeable to them. Through a hole in the bottom of the trough, the water might be let out every two or three days, and the troughs filled again with fresh water, which by this means would continue sweet and clean.

By this method, I am persuaded, they might be raised to advantage, and perhaps, in time, become no contemptible branch of commerce. They appear to me much easier raised than the *Italian* or foreign silk worms. I did not lose one by sickness. They hatch so late in the spring that they are not subject to be hurt by the frost. Neither lightnings nor thunder disturb them, as they are said to do foreign worms. And as they lie so long in their chrysalis state, the cocoons may be unwinded at leisure hours in the ensuing winter. One thing more in their favour is, that one of their cocoons will weigh more than four of the foreign worms ; and, of consequence, it may be presumed, will yield a proportionable greater quantity of silk. These properties, not to mention their being natives, and therefore accustomed to our climate, and the variety of vegetables, on which they feed, must render them much more promising than the eastern or foreign worms, and, it is to be hoped, will induce some who have leisure to make further trials of them. Any time before the middle of *May* will do to collect them. Now is the time to collect the cocoons, and with a little pains a sufficient number of them may be found in almost any swamp or level piece of land, to make a beginning.

I would advise them to prepare boxes, in the following manner : They may be of any convenient length, about six inches deep, and four or five wide ; without a bottom, and instead of a close cover for the top, let there be strips of wood nailed on, so close to each other as not to admit the worms crawling through. Let there, also, be several holes in one, or both sides, big enough for the worms to be put in at, as they want to spin, and then stopped up. The inside should be washed with a solution of gum Arabic, or cherry tree gum. The boxes may stand on any flat place to prevent the worms getting out ; and when the silk is to be unwound, by immersing the boxes in warm water, the cocoons may be taken out without breaking the threads of silk.